



TENNESSEE DEPARTMENT OF

EDUCATION
FIRST TO THE TOP

Welding II

Primary Career Cluster:	Advanced Manufacturing
Consultant:	Casey Haugner Wrenn, (615) 532-4879, Casey.Haugner@tn.gov
Course Code:	6033
Pre-requisite(s):	<i>Welding I</i> (6078) Recommended: <i>Algebra</i> (0842, 3102), <i>Geometry</i> (0843, 3108), <i>Physical Science</i> (3202)
Credit:	2
Grade Level:	11-12
Graduation Requirement:	This course satisfies two of three credits required for an elective focus when taken in conjunction with other Advanced Manufacturing courses.
Programs of Study and Sequence:	This is the third course in the <i>Welding</i> program of study.
Aligned Student Organization(s):	Skills USA: http://www.tnskillsusa.com Brandon Hudson, (615) 532-2804, Brandon.Hudson@tn.gov
Coordinating Work-Based Learning:	Teachers are encouraged to use embedded WBL activities such as informational interviewing, job shadowing, and career mentoring. For information, visit http://tn.gov/education/cte/work_based_learning.shtml .
Available Student Industry Certifications:	American Welding Society Entry Welder
Dual Credit or Dual Enrollment Opportunities:	There are available dual credit/dual enrollment opportunities for this course. If interested, reach out to a local postsecondary institution to establish an articulation agreement.
Teacher Endorsement(s):	551, 552, 553, 554, 555, 556, 557, 584, 705, OR any other Occupational License endorsement with AWS Industry Certification, BAT, or Certified Welding Educator Certification.
Required Teacher Certifications/Training:	Must hold AWS Industry Certification, BAT, or Certified Welding Educator Certification
Teacher Resources:	http://www.tn.gov/education/cte/Manufacturing.shtml

Course Description

Welding II is designed to provide students with opportunities to effectively perform cutting and welding applications of increasingly complexity used in the advanced manufacturing industry. Proficient students will build on the knowledge and skills of the *Welding I* course and apply them in novel environments, while learning additional welding techniques not covered in previous courses. Specifically, students will be proficient in (1) fundamental safety practices in welding, (2) gas metal arc welding (GMAW), (3) flux cored arc welding (FCAW), (4) gas tungsten arc welding (GTAW), and (5) quality control methods. Upon completion of the *Welding II* course, proficient students will be eligible to complete the American Welding Society (AWS) Entry Welder qualification and certification. Standards in this course are aligned with Tennessee State Standards for English Language Arts & Literacy in Technical Subjects and Tennessee State Standards in Mathematics.*

Program of Study Application

This is the third course in the *Welding* program of study. For more information on the benefits and requirements of implementing this program in full, please visit the Advanced Manufacturing website at <http://www.tn.gov/education/cte/Manufacturing.shtml>.

Course Standards

Safety

- 1) Accurately read, interpret, and demonstrate adherence to safety rules, including rules published by the (1) National Science Teachers Association (NSTA), (2) rules pertaining to electrical safety, (3) Occupational Safety and Health Administration (OSHA) guidelines, (4) American Society for Testing Materials; ANSI Z49.1: Safety and Welding, Cutting, and Allied Processes, and (5) state and national code requirements. Be able to distinguish between rules and explain why certain rules apply. Complete safety test with 100 percent accuracy. (TN Reading 3, 4; TN Writing 2, 4)
- 2) Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, store, and maintain safe operating procedures with tools and equipment. (TN Reading 3, 4)

Gas Metal Welding (GMAW)

- 3) Safely set up equipment for gas metal arc welding (GMAW). Identify and explain the equipment, equipment setup, power sources, and the electrical current used in the welding process. Drawing on multiple resources, research the advantages of using GMAW over conventional electrode-type arc (stick) welding. Write a brief informative paper distinguishing the characteristics. For example, explain why it is easier to control the small molten weld pool using the GMAW process. (TN Reading 2, 4, 5, 7, 9; TN Writing 2, 4)
- 4) Research the American Welding Society (AWS) filler metal classification system, and write a brief paper explaining the system, discussing the multiple factors that affect electrode selection for gas metal arc welding (GMAW). For example, the 80 in ER80S-D2 designates the minimum tensile strength of the deposited weld metal in thousands. (TN Reading 2, 3, 4, 5, 7; TN Writing 2, 4)

- 5) Using the gas metal arc welding (GMAW) process and various metal transfer methods (e.g., short-circuit, pulse-arc, globular, and spray transfer), demonstrate how to pad beads and make fillet welds on plain carbon steel in all feasible positions (e.g., horizontal, flat, vertical, overhead). Summarize the demonstration results, distinguishing between the metal transfer methods used, and explain the equipment adjustments made to change between metal transfer methods as if narrating a technical process to an audience. (TN Reading 3, 4, 5, 7; TN Writing 2, 4; TN Math N-Q, G-GMD)

Flux Cored Arc Welding (FCAW)

- 6) Safely set up equipment for flux cored arc welding (FCAW). Identify and explain the equipment, equipment setup, power sources, and the electrical current used in the welding process. Drawing on multiple resources, research the advantages and limitations of FCAW. Write a brief informative paper distinguishing these characteristics. For example, determine which types of metals and alloys are most applicable for the use of FCAW. (TN Reading 2, 4, 5, 7, 9; TN Writing 2, 4)
- 7) Refer to previous research conducted on the filler metal classification system by the American Welding Society (AWS). Using proper domain-specific terminology, explain in a presentation to a technical audience the multiple factors that affect electrode and shielded gas selection for flux cored arc welding (FCAW). For example, manufacturers sometimes consider the exact composition of fluxes a trade secret and do not provide enough details to classify electrodes. As a result, AWS uses G for electrodes that have not been classified. (TN Reading 2, 4, 5, 6, 7; TN Writing 2, 4)
- 8) Using various electrodes and the flux cored arc welding (FCAW) process, demonstrate how to pad beads and make fillet welds on plain carbon steel in all feasible positions (e.g., horizontal, flat, vertical, overhead). Over time, routinely document observations such as the effects of metal surface conditions, voltage drop, welding position, and wire feed speed. Summarize the demonstration results of using various electrodes and explain the findings using supporting evidence from the AWS metal classification system and other resources. (TN Reading 3, 4, 5, 7; TN Writing 2, 4; TN Math N-Q, G-GMD)
- 9) Identify and explain the following distinctive features about flux cored arc welding (FCAW): arc-control, oxidation-prevention, self-shielded FCAW, and gas-shielded FCAW. Describe and demonstrate specific examples of how metal transfer is affected by arc-control, self-shielded, and gas-shielded FCAW. Explain the importance of using recommended gas mixtures. (TN Reading 2, 4, 5, 7; TN Math N-Q)

Gas Tungsten Arc Welding (GTAW)

- 10) Safely set up equipment for gas tungsten arc welding (GTAW). Identify and explain the equipment, equipment setup, power sources, and the electrical current used in the welding process. Drawing on multiple resources, compare and contrast water-cooled welding torches versus air-cooled welding torches used in GTAW. Write a brief paper distinguishing the characteristics and the appropriate applications of each torch type. For example, determine which torch is preferred in production welding contexts and explain why. (TN Reading 2, 4, 5, 7, 9; TN Writing 2, 4)

- 11) Refer to previous research conducted on the filler metal classification system by the American Welding Society (AWS). Discuss the multiple factors that affect electrode selection for gas tungsten arc welding (GTAW). For example, pure tungsten (EWP) is not typically used with alternating current (AC) welding of materials because it has poor heat resistance and electron emission. (TN Reading 2, 3, 4, 5, 7, 9; TN Writing 2, 4)
- 12) Using various electrodes and the gas tungsten arc welding (GTAW) process, demonstrate how to pad beads and make fillet welds on plain carbon steel, stainless steel, and aluminum in all feasible positions (e.g., horizontal, flat, vertical, overhead). Summarize the demonstration results of using various electrodes and explain the findings using supporting evidence from the AWS metal classification system and other resources. (TN Reading 3, 4, 5, 7; TN Writing 2, 4; TN Math N-Q, G-GMD)
- 13) Identify and explain the following distinctive features about gas tungsten arc welding (GTAW): arc-control, oxidation-prevention, and gas-shielded GTAW. Describe and demonstrate specific examples of how metal transfer is affected by various shielded gas GTAW (e.g., argon, helium, hydrogen, nitrogen). Identify which gases are noble inert gases and explain why this is a distinguishing characteristic. (TN Reading 2, 4, 5, 7, 9; TN Math N-Q, G-GMD)

Quality Control

- 14) Measure and visually inspect welded products for acceptability to American Welding Society QC-10 standards. Record discontinuities and defects and compare data to given project specifications using class-defined analysis methods. Interpret and communicate results both written and verbally. If necessary, recommend changes that will reduce the number of product defects during the manufacturing process. (TN Reading 1, 3, 4, 7; TN Writing 1, 4; TN Math N-Q, G-GMD)
- 15) Drawing upon multiple resources, research nondestructive testing beyond visual inspection, such as penetrant inspection, magnetic particle inspection, radiographic inspection, and ultrasonic inspection. Describe how these tests are applied as quality control techniques to prevent manufacturing defects in welding. Compare and contrast these techniques and provide specific examples for when they are most appropriately used. Cite evidence to justify the examples. Demonstrate the proper use of the magnetic particle and penetrant inspection tests on weldment samples of gas metal arc welding (GMAW), flux cored arc welding (FCAW), and gas tungsten arc welding (GTAW) processes. (TN Reading 1, 3, 6, 9; TN Writing 1, 4; TN Math N-Q, G-GMD)
- 16) Describe and distinguish between the guided-bend test and the free-bend test. Explain when it is most appropriate to apply each test. Demonstrate the use of each test and properly document results on a mock qualification test record form conforming to the American Welding Society (AWS) requirements. For example, perform root- and face-guided bend tests on a butt joint weld coupon. (TN Reading 3, 4, 5, 7, 9; TN Writing 2, 4; TN Math N-Q, G-GMD)

Industry Certification and Portfolio

- 17) Pursue the industry certification exam (e.g., American Welding Society SMAW module) using the shielded metal arc welding (SMAW) process. Demonstrate how to make multiple-pass open-butt groove welds on plain carbon steel in all feasible positions (e.g., horizontal, flat, vertical, overhead) conforming to American Welding Society quality standards)
 - 18) In preparation for industry certification exams (e.g., American Welding Society GMAW, FCAW, and GTAW modules), complete assigned team projects that incorporate the following welding processes in order to design, fabricate, evaluate, and test products made in this course. For each project, produce a technical report documenting illustrations, findings, and justifications for project solutions. Compile photographs of each project, along with technical documentation, into a portfolio of work.
 - a. Using the gas metal arc welding (GMAW) process and various metal transfer methods (e.g., short-circuit, pulse-arc, and spray transfer), demonstrate how to make a complete joint penetration weld on plain carbon steel in all feasible positions (e.g., horizontal, flat, vertical, overhead) conforming to American Welding Society quality standards.
 - b. Using the flux cored arc welding (FCAW) process, demonstrate how to make a complete joint penetration weld on plain carbon steel in all feasible positions (e.g., horizontal, flat, vertical, overhead) conforming to American Welding Society quality standards.
 - c. Using electrodes and the gas tungsten arc welding (GTAW) process, demonstrate how to complete joint penetration welds on plain carbon steel, stainless steel, and aluminum in all feasible positions (e.g., horizontal, flat, vertical, overhead) conforming to American Welding Society quality standards.
- (TN Reading 3, 4, 5, 7, 8, 9; TN Writing 2, 4, 5, 6, 7, 8, 9; TN Math N-Q, G-GMD)

Standards Alignment Notes

*References to other standards include:

- TN Reading: [Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Reading Standards for Literacy in Science and Technical Subjects 6-12; Grades 11-12 Students (page 62).
 - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standard 10 at the conclusion of the course.
- TN Writing: [Tennessee State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects](#); Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6-12; Grades 11-12 Students (pages 64-66).
 - Note: While not directly aligned to one specific standard, students who are engaging in activities outlined above should be able to also demonstrate fluency in Standards 3 and 10 at the conclusion of the course.
- TN Math: [Tennessee State Standards for Mathematics](#); Math Standards for High School: Number and Quantity, Geometry.
 - Note: The standards in this course are not meant to teach mathematical concepts. However, the concepts referenced above may provide teachers with opportunities to collaborate with mathematics educators to design project-based activities or collaborate

on lesson planning. Students who are engaging in activities listed above should be able to demonstrate quantitative and geometric reasoning as applied to specific technical concepts. In addition, students will have the opportunity to practice the habits of mind as described in the eight Standards for Mathematical Practice.

- P21: Partnership for 21st Century Skills [Framework for 21st Century Learning](#)
 - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.